Rec'd Wyeth (J. A.)

AUTHOR'S COMPLIMENTS.

A PRIZE ESSAY

UPON

THE SURGICAL ANATOMY

OF THE

TIBIO-TARSAL ARTICULATION,

WITH SPECIAL REGARD TO

AMPUTATIONS AT THIS JOINT.

BY

JOHN A. WYETH, M. D.

NEW YORK.

SURGEON GEN'LS OFFICE
13.62
LIBRARY.

[Reprinted from AMERICAN JOURNAL OF MEDICAL SCIENCES, April, 1876.]

[This Essay was awarded the Annual Prize of One Hundred Dollars, offered by Prof. James R. Wood, to the Alumni Association of the Bellevue Hospital Medical College, for "The best Essay on any subject connected with Surgical Pathology or Operative Surgery."—*Feb.*, 1876.]

THE SURGICAL ANATOMY

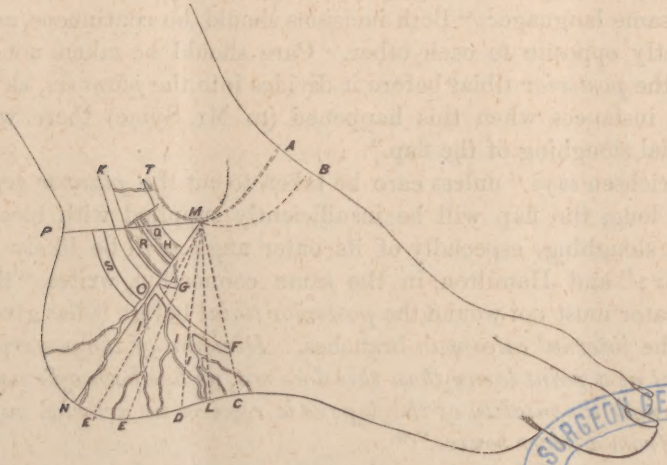
OF THE

TIBIO-TARSAL ARTICULATION,

WITH SPECIAL REGARD TO AMPUTATIONS AT THIS JOINT.

(As deduced from 80 consecutive dissections.)

DIAGRAM SHOWING THE ARTERIAL SUPPLY TO THE CALCANEAN REGION, ON THE TIBIAL SIDE OF THE FOOT—(DRAWN BY THE AUTHOR, FROM THE AVERAGE OF 80 DISSECTIONS).



SURGEON GEN'LS OFFICE
LIBRARY.

M.—Internal Malleolus.
PMCN.—Tibio-tarsal Quadrilateral, the Surgical Region of this Articulation.
K.—Posterior Tibial Artery.
O.—Its point of bifurcation into
G.—Internal Plantar and
F.—External Plantar Artery.
III.—Calcanean Branches of External Plantar.
T.—Articular Branches from Posterior-Tibial.
H.—Articular Branch from Internal Plantar.
Q.—Tendon of Tibialis Posticus Muscle.
R.—Tendon of Flexor Longus Digitorum.
S.—Tendon of Flexor Longus Pollicis.
MC.—The line of incision of Gross.
ML, MD, ME, MB.—Lines of incision showing that the nearer the incision approaches the heel, the more danger is incurred of cutting off the principal blood-supply to the Calcanean Flap, in amputation.
MN.—Line crossing the usual point of bifurcation of the Posterior-Tibial.
MA, MB.—Anterior incision.

In both the amputations at the *tibio-tarsal* articulation, (Syme's and Pirogoff's) surgeons agree that the perfect success of the operation depends upon the vitality, *i.e.*, the non-interference with the blood supply of the inferior or calcanean flap.

Descriptive and surgical anatomists and operative surgeons, agree with remarkable unanimity, that the integrity of this flap is dependent upon its blood supply, partly, from the *anterior and posterior peroneal* arteries, on the outer side, but principally from the *calcanean* branches of the *posterior tibial* on the inner side of the ankle joint.

In reference to this, Gross says: "Care should be taken not to wound the *posterior tibial* prior to its separation into its *plantar* branches, otherwise sloughing of the soft parts might ensue from deficient nourishment;" while Valentine Mott, in his edition of Velpeau's Surgery (quoting from Syme), uses almost the same language: "Both incisions should be continuous, and exactly opposite to each other. Care should be taken not to cut the *posterior* tibial before it divides into the *plantars*, as in two instances when this happened (to Mr. Syme) there was partial sloughing of the flap."

Erichsen says "unless care be taken to cut the *plantar arteries* long, the flap will be insufficiently supplied with blood, and sloughing, especially of its outer angle, will be likely to occur;" and Hamilton, in the same connection, writes, "the operator must not wound the *posterior tibial* before it has given off the *internal calcanean* branches. *Division of the posterior tibial at a point lower than this does not, as has been affirmed, endanger the vitality of the flap, as it receives no arterial supply from a lower source.*" *

Holmes is of the opinion that "the integrity of the *posterior tibial*, though desirable, is by no means essential, provided the rest of the subcutaneous tissue has been left uninjured." †

---

* The italics are the writer's, not Prof. Hamilton's.

† Laying no claim to personal experience, the author cannot understand how it would be possible to dissect out a bone so full of indentations and rough eminences, so covered with the insertions and origins of ligaments and muscles, and sheaths through which tendons play, and leave "the subcutaneous tissue uninjured." There are no less than thirteen muscles in relation to this dissection, to say nothing of ligaments.

Apropos to the generally accepted idea of the origin of this principal blood supply, the following quotations are given :

"The *internal calcanean* consist of several large branches, which arise from the *posterior tibial* just before its division." —*Gray.*

Quain, while mentioning these vessels in his text only in a general way, gives them specially in his diagrams as branches from the *posterior tibial*, anastomosing with branches of the *posterior peroneal.*

"The *internal calcanean branches*, three or four in number, proceed from the *posterior tibial* artery immediately before its division."— *Wilson.*

"The *calcanean arteries* are two or three branches from the lower part of the *posterior tibial.*"—*Leidy.*

"Under the arch of the calcaneum the *posterior tibial* gives origin, 1st, to branches distributed to the periosteum, to the adductor (?) of the great toe, the short flexor of the toes, and to the superficial structures ; and 2d, to other branches of less calibre, which mount the inner border of the foot to anastomose with descending branches of the *internal malleolar* branch of the *anterior tibial.*" *

Hyrtl mentions the operation of amputation at the ankle-joint, but does not consider the surgical anatomy relating to this procedure.

I assert without equivocation that the arterial supply to the calcanean region, as given above, is not correct in the main ; and that the operative surgery at the ankle-joint, based upon the idea that the arterial supply to the calcanean flap is derived from the posterior tibial, is unsafe.

Having failed to find this distribution, as given in the text-books some years ago, I determined to investigate this matter thoroughly, and to that end, made 80 consecutive dissections

---

* Sous le vôute du calcaneum la tibiale postérieure donne naissance ; 1°, a des rameaux qui se distribuent au périoste, au muscle adducteur du gros orteil, au court fléchisseur commun des orteil, et aux téguments ; 2°, a d'autres rameaux d'un moindre calibre qui remontent sur le bord interne du pied pour s'anastomoser avec des rameaux descendants de la malléolaire interne, branche de la tibiale antérieure.—*Sappey.*

of this region, with all requisite care, the result of which is given in the table and *résumé* appended to this essay.

In 72 of 80 cases the *posterior tibial* bifurcated into its *plantar* branches on a line between the lower border of the inner malleolus and the middle or centre of the heel's convexity. In four of the remaining cases the separation occurred one-fourth of an inch, and in the other four cases one-half an inch *below* this line M N (see diagram). Any variations in the point of division tend, in all cases, toward the line of incision in amputations in this region.

In 38 out of 80 dissections (*almost one-half*) there was not a single *calcanean artery* derived from the *posterior tibial*, (K O, see diagram). So it must follow that any line of incision that approximates the terminal bifurcation of this vessel will, in a great many cases, endanger the blood supply, and consequently the success of the operation.

I cannot think that the exceptional cases in which good recoveries have resulted after division of this vessel above or at its bifurcation are arguments of any weight in favor of the incision "well back toward the heel," when compared with the fact that, in such a great proportion of cases, there is no blood supply above this point to the inner side of the flap, and that in some recorded cases where this accident has happened dangerous sloughing occurred.

From the standpoint of surgical anatomy, the incision recommended and practised by Prof. Gross, and represented in the annexed diagram by the line M C, is the most rational, since it is farthest removed from the most constant blood supply to this inferior flap, viz., the *calcanean branches of the external plantar artery.*

In 80 cases 51 calcanean branches were derived above the bifurcation.

In 80 cases 18 were derived opposite this point.

While out of 80 cases the number of calcanean branches derived from the *external plantar* artery and distributed to the posterior or calcanean flap, safely within the line of incision of Gross (M C) given above, was 221, or more than three times in number, and carrying, without the least exaggeration, twice

the volume of blood, of those derived opposite to and above the bifurcation.

Erichsen in his text says: "It is of importance that the incision across the heel should be carried well back over its point. Unless this be done, a large, cup-shaped cavity will be left, in which blood and pus will accumulate, and retard the cicatrization of the stump. The principal point to be attended to, however, is that the *plantar arteries* be cut long."

These two propositions I hold as anatomically incompatible. The arteries will be cut short, *dangerously short*, if the incision is carried "well back over the point of the heel," while the great danger of retardation of healing on account of retained septic matter might be obviated by leaving the wound open for drainage at its most dependent part, or cutting a drainage hole in the under surface of this cup-shaped flap, as is recommended by surgeons of experience.

In fact, strict attention to cleanliness should render the collection and absorption of septic matter impossible.

Hamilton, agreeing with Erichsen, perhaps a little more emphatic in his method of expressing it, says: "The lines of this second incision ought not to fall vertically from the malleoli, that is, not at right angles with the sole of the foot, as this would give a redundancy of flap; it would also increase the danger of sloughing, etc. . . . . It is better to carry the lines of incision from the two malleoli a little backwards, so that the knife will cross the bottom of the foot about an inch and a half further back; and in the case of an unusually long heel it will be proper to carry the incision backwards two inches." And in the same connection as quoted before he adds: "The operator must not wound the *posterior tibial* artery before it has given off the *internal calcanean* branches, which supply the cellulo-adipose tissue and integument composing the posterior flap. Division of the *posterior tibial* at a point lower than this does not, as has been affirmed, endanger the vitality of the flap, as it receives no arterial supply from a lower source."

The language of this eminent surgeon is decisive and emphatic.

In 38 *of* 80 *dissections there was not an artery that I could*

find, by careful dissection, derived from the posterior tibial and distributed to the calcanean region, while in every case of 80 *dissections there was one or more branches derived from the external plantar and distributed directly to this part.*

Lister, author of the chapter on amputations in Holmes's Surgery, advises that the calcanean incision be made either vertical to or sloping towards the heel, commencing at the tip of the external malleolus, and going under the foot to a point considerably below and behind the tip of the inner malleolus. . . . . Even the integrity of the *posterior tibial* artery, though desirable, is by no means essential, provided the rest of the subcutaneous tissue has been left uninjured.*

The great unevenness of the os calcis, its peculiar shape, covered with the attachments of muscles, sheaths, and ligaments, renders it *anatomically* difficult to be dissected out in this operation, without wounding, more or less, the subcutaneous tissue, upon which, Mr. Lister says, the integrity of the flap depends. Moreover, if the "integrity of the *posterior tibial* is not essential," why does this gentleman recommend so positively an incision, that must always save this vessel to the operation? Why not cut an "inch and a half, or, in the case of a long heel," two inches back of the vertical line (as Hamilton does), where he would have plenty of flap and an easier dissection?

The language of these two phases of his operation is irreconcilable, and the assertion that "the integrity of the *posterior tibial* artery, though desirable, is not essential," is not strictly in accordance with the clinical history of this amputation, and is utterly at variance with the anatomy of the blood supply to the calcanean region.

Stephen Smith, in his comprehensive report, says the necessity for re-amputation in this operation is three per cent. *greater* than in any other.

Perhaps the cause of this may arise from the reckless sacrifice of the arterial supply to this region, sanctioned by such eminent surgeons as I have quoted.

The writer of this essay, deeming it unnecessary to introduce

---

* Holmes's Surgery, Vol. V., pp. 643, 644.

any further quotations and comments, since he wishes to be concise, simply begs leave to state that he has entrusted his work to no one; that he measured every dissection with accuracy, and noted it on the spot; and that, in differing so widely in his results and conclusions with gentlemen of such eminence (whom it seems almost sacrilege to contradict), he reiterates his assertion that the *surgical anatomy of this region has, heretofore, not been correctly described.*

TABLE

SHOWING ORIGIN OF THE CALCANEAN BRANCHES OF THE POSTERIOR TIBIAL AND EXTERNAL PLANTAR ARTERIES, AS DEDUCED FROM NOTES ON EIGHTY CONSECUTIVE DISSECTIONS.

Number.	Number of Calcanean Branches derived from the Posterior Tibial Artery.	Number of Calcanean Branches derived opposite the Terminal Bifurcation of the Posterior Tibial.	Number of Calcanean Branches derived from the External Plantar Artery within 1½ inches of its origin.
1	0	0	3
2	1	0	3
3	0	0	3
4	0	0	7
5	0	0	4
6	2	0	5
7	0	1	4
8	1	0	2
9	0	0	1
10*	1	0	3
11	0	0	1
12†	1	0	3
13	1	0	4
14	0	0	4
15	1	0	3
16	1	0	3
17	0	0	4
18	1	0	2
19	0	0	3
20	1	1	3
21	1	1	2
22	1	0	2
23	0	0	2
24	0	0	3
25	0	0	2
26	0	1	2
27	1	1	4
28	1	1	1
29	1	0	2
30	1	0	2
31	0	0	3
32	1	1	2
33	1	0	3
34	2	0	2
35	1	1	2
36	0	0	3
37	0	0	6
38	1	0	2
39	1	0	3
40	0	1	1

* This case bifurcated one-half inch lower than usual.

† This case bifurcated one-half inch lower than usual.

Number.	Number of Calcanean Branches derived from the Posterior Tibial Artery.	Number of Calcanean Branches derived opposite the Terminal Bifurcation of the Posterior Tibial.	Number of Calcanean Branches derived from the External Plantar Artery within 1⅛ inches of its origin.
41*	2	0	2
42	1	0	3
43	1	0	2
44	0	0	3
45	0	1	2
46	0	1	4
47	0	0	2
48	1	0	3
49	2	0	2
50	0	0	3
51	0	0	3
52†	1	0	2
53	2	0	6
54	1	1	4
55‡	0	0	3
56	2	0	0
57	1	0	1
58	0	1	3
59	0	0	2
60§	2	0	1
61	1	0	2
62‖	2	0	2
63	1	0	3
64¶	0	0	3
65	1	1	3
66	0	0	3
67	0	2	1
68	0	0	3
69	1	0	4
70	0	0	3
71	1	0	3
72	1	0	2
73	2	0	2
74	0	1	4
75	0	0	4
76	0	0	3
77	1	0	3
78	0	0	5
79	0	0	2
80	0	1	1
Total.....	51	18	221

* This case bifurcated one-fourth inch lower than usual.

† This case bifurcated one-fourth inch lower than usual.

‡ This case bifurcated one-fourth inch lower than usual.

§ This case bifurcated one-half inch lower than usual.

‖ This case bifurcated one-half inch lower than usual.

¶ This case bifurcated one-fourth inch lower than usual.

SUMMARY OF THE SURGICAL ANATOMY OF THE ARTERIAL SUPPLY TO THE TIBIO-TARSAL REGION, AS DEDUCED FROM 80 DISSECTIONS.

In 72 of 80 cases the posterior tibial artery bifurcated into the external and internal plantar, on a level with a line drawn from the most dependent portion of the internal malleolus, to the middle of the heel's convexity. (See M N, fig. 1.)

In 4 of 80 cases this bifurcation occurred ¼ inch below this point.

In 4 of 80 cases it was ½ inch below this point; any variation from the usual point of division tending, in my experience, *invariably downward.*

Although anatomists give the arterial supply to the calcanean region (*internal calcanean arteries*) as coming from the *posterior tibial* artery (as shown in extracts given heretofore), the *résumé* of tabulated dissections shows that out of a total of 80 cases, in 38 *there was not a single calcanean branch derived above the terminal bifurcation of the posterior tibial artery,* while in all of these 80 dissections one or more good-sized *calcanean arteries* were derived from the *external plantar* within one and a quarter inches of its origin.

In 80 cases the number of *calcanean* arteries derived from the *posterior* tibial was 51.

In 80 cases 18 branches were derived opposite the point of bifurcation, and distributed to this region.

In 80 cases the number of *calcanean arteries* derived from the *external plantar* was 221, and every one of these was safely inside the line of incision in amputations at the ankle-joint, when that incision is not more than one-half inch posterior to the axis of the leg (see M C, fig. 1), with the foot at right angles to the leg. In all cases *articular branches* are derived either from the *posterior tibial* or *internal plantar*, or from both. In some exceptional cases the *internal plantar* gave off small branches to the heel.

The anterior flap is plentifully supplied in all instances by branches from the *anterior tibial*, especially the *malleolar* arteries.

The *anterior* and *posterior peroneal* distribute branches to the outer portion of the calcanean flap, those from the *posterior* anastomosing with the *calcanean* branches of the *external plantar*, and with those of the *posterior tibial*, when they are present. I do not think the branches from the *peroneal arteries* sufficiently large to supply blood enough to maintain the integrity of the calcanean flap, especially when their anastomoses are cut off by section of the *posterior tibial*, or of its *plantar* branches, too near their origin.

The relation of the *posterior tibial* artery is quite constant with the two muscles between which it runs; the flexor longus digitorum in front, and the flexor longus pollicis behind. The most reliable guide to this vessel is its pulsation, but in the event the tourniquet is applied, the thumb should be placed over the middle of a line drawn from the inner malleolus to the centre of the heel's convexity, while the four lesser toes are held still by an assistant, the surgeon moves the great toe, and marks the point at which he feels the tendon gliding under his thumb. The tendon of the longus digitorum is found in the same manner, and half-way between the two a curved incision, with its concavity towards the malleolus, will be over the artery. The relations of the veins on either side, and of the *posterior tibial nerve* behind, are among the least variable features of the anatomy of this region. In two cases I have seen the artery immediately behind the inner malleolus. When the *posterior tibial* is small, the *peroneal* branches undergo compensatory enlargement.

P.S.—Since closing these notes, some weeks ago, the writer has made seven additional dissections of this region, with the following result:

In 4 out of 7 cases, *calcanean* branches originated from the posterior tibial artery—1, one inch; 1, one-half inch, and 2, one-eighth of an inch above the bifurcation.

In 7 cases, 2 *calcanean* branches were derived opposite the bifurcation.

In 7 cases, 19 *calcanean* branches were derived from the external plantar, within one inch of its origin; 3, within one-sixteenth; 2, within one-eighth; 1, within one-fourth; 4, within

one-half; 4, within three-fourths, and 5 within one inch of the bifurcation. Articular branches were, as usual, from posterior tibial and internal plantar.

The posterior tibial bifurcated in every case, as usual. (See diagram.)